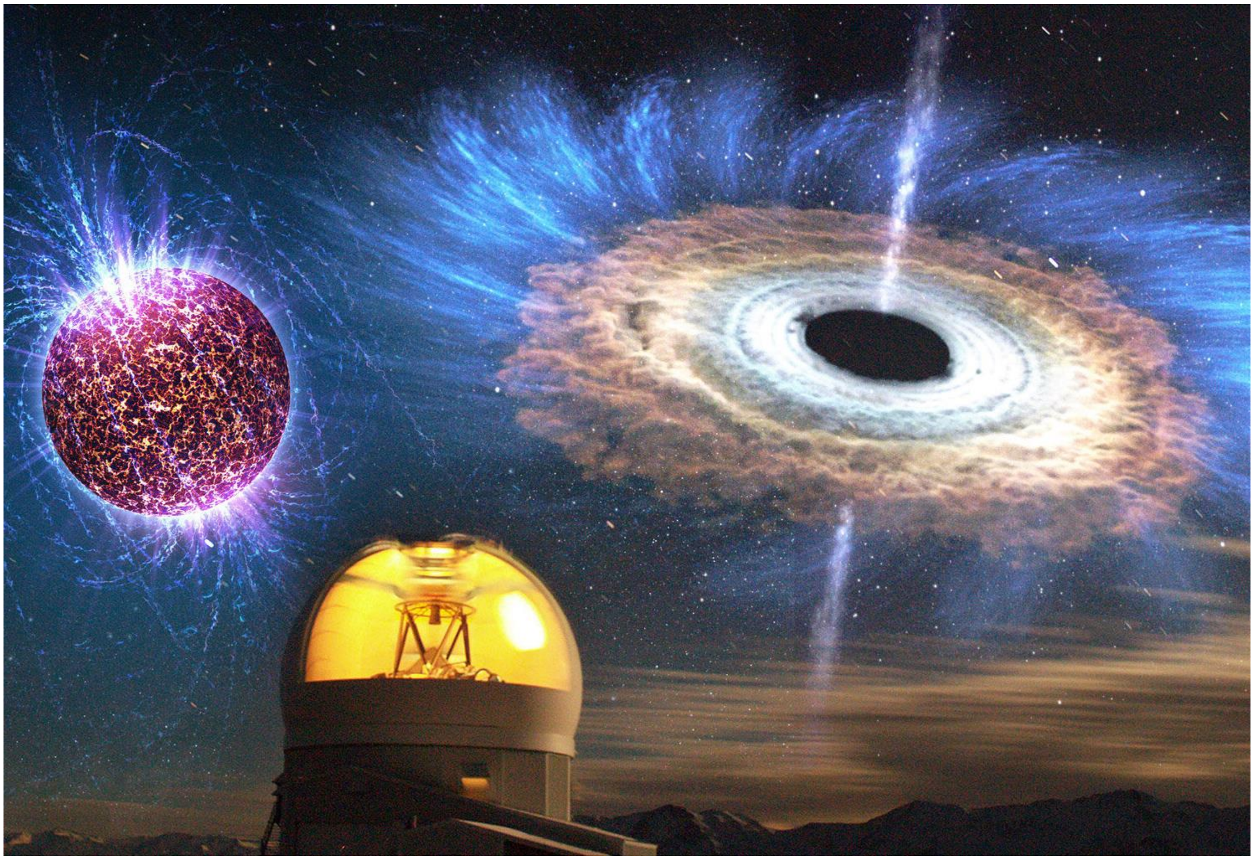
The Hijacking of Indian Astronomy



Author : Anil Narayanan

In the field of astronomy, ancient India appears to have produced a significant amount of output. While the west has acknowledged the great age of the Indian civilization, the same has not been accorded to Indian Astronomy, the main reason for which has been political.

Nearly a hundred years ago, English historian George Rusby Kaye remarked that "*the History of Indian Astronomy has a considerable history of its own*."

He was referring, of course, to the greatly fluctuating opinion in Europe, during the 18th and 19th centuries, regarding the substance and originality of Indian Astronomy.

It is widely acknowledged that the Indian civilization is among the oldest in the world, if not *the* oldest. The vast region of the Indian subcontinent, which can comfortably house the entire continent of Europe, has been home to many nations, cultures, customs, languages and religions over the millennia.

The most ancient texts of Indian literature show clear evidence of being at least 6000 years old. The subcontinent has also produced the two longest epics ever written by the hand of man.

In the field of astronomy too, ancient India appears to have produced a significant amount of output. We read in the ancient texts of at least 18 major treatises on astronomy, most of which have unfortunately been lost.

While the West has acknowledged the great age of the Indian civilization, the same has not been accorded to Indian Astronomy, the main reason for which has been political. The bulk of Western research into Indian Astronomy was carried out during the 18th and 19th centuries, when India was a colony of the British, and a major effort was on by the colonizers to impose their culture and religion on the Indians, to make them pliable and comfortable with the idea of western subjugation. In such a scenario, it is only to be expected that Indian Astronomy was deprecated by western scholars, and even accused of being plagiarized from Europe (read Greeks).

Even so, the history of Indian Astronomy from a European perspective is an

enthralling area of research. The views and counter-views of the European scholars of those times make for fascinating reading. While the majority espoused the vision that the Indians had borrowed their Siddhantic Astronomy from the Greeks, a small minority took the opposite view.

Unlike the Indians, the West has had an enormous head-start in their extolling and eulogizing of Greek Astronomy. As one enters the field of Archeo-Astronomy, one becomes acutely aware of the vast gulf that exists between resources available for Greek and Indian astronomies. For anyone wishing to learn the ins and outs of the Greek science, there are bountiful resources available, including Otto Neugebauer's

comprehensive three-volume set on Greek Astronomy.

In contrast to Greek Astronomy, where the single text of Ptolemy's *Almagest* reigns supreme, Indian Astronomy has multitudes of books, each with its own unique significance. There has been little effort, as yet, to synthesize the essence of these Indian texts into a comprehensive resource on Indian Astronomy. The available literature, such as it exists, can be aptly described as "meager", with a good chunk of it having been written by western scholars, with their typical Greek bias. Most Indian papers and articles that one comes across appear to only skim the surface of its topic, utterly lacking in depth and rigor. Indian Astronomy, it

appears, waits in hope for its Neugebauer.

In this series of articles, we will firstly examine the discovery of Indian Astronomy by the western world, starting in the late 17th century, and the effusive praise that was showered on it by various Europeans. Later, we will delve into the politics of colonization that led eventually to the enforced deprecation of Indian Astronomy by western scholars, with such lasting effects, that even today, in the eyes of the world, Indian Astronomy bears the ignominious stamp of being a second-hand science, borrowed from foreign sources by incompetent, bungling amateurs.

How did that initial euphoria for Indian Astronomy in Europe, of nearly ten

decades, turn within a short period of time into ridicule and contempt? How did this reversal come about? After a hundred years of research, books and articles – all commending Indian Astronomy for its originality, antiquity, depth and accuracy – how did all that get swept away, to be replaced with the conclusion that the Indians had simply borrowed it all from the Greeks? There is surely a good story somewhere in there.

From a European perspective, the evolution of the history of Indian Astronomy can be divided into three distinct phases: 1) Discovery and Euphoria, 2) Entry of Colonial Politics and Start of Deprecation, 3) Full-Blown Deprecation. We will examine these phases one by one.

Phase-I (Discovery and Euphoria)

The seminal event in Europe’s discovery of Indian Astronomy was the publication in 1691 of a small treatise on Indian astronomical rules by Jean Dominique Cassini, the renowned French-Italian astronomer.

Ironically, Europe first learnt of Indian Astronomy, not from India, but from Siam (Thailand). It so happened that a French envoy had been dispatched in 1687 to Siam, where there existed a flourishing Buddhist-Hindu kingdom. That gentleman brought back to Paris several artifacts and curiosities from the Kingdom, including an obscure manuscript relating to the astronomical traditions of that country.

That enigmatic manuscript, which may well have ended up lying unnoticed in some dusty corner of the Royal French archives, somehow passed into the hands of Cassini, who was able to decipher its cryptic contents, including the fact that the document originated in India.

Though the manuscript was only a small fragment of its parent volume at Siam, it contained enough material to provide tantalizing hints of the width and depth of Indian Astronomy. There were, however, some difficulties on the way for Cassini, who was working with a French translation of the manuscript: 1) The text of the manuscript was rather terse, with no explanations provided, 2) Some vital data appeared to be missing, 3) Some of the concepts and formulations in the

manuscript were entirely new to him, 4) Several calculations were presented in an obfuscating manner, so as to obscure and conceal the nature of the operations behind them, 5) The French translator had kept the original Sanskrit technical terms as is, without translating them into French, or providing the meaning of these terms.

In the face of these seemingly unsurmountable difficulties, where lesser men may have thrown up their hands, Cassini persevered and overcame them with passion and brilliant insight, to provide Europe with the keys to Indian Astronomy. One should surely thank the fates for having delivered the manuscript into his capable hands. Not for nothing, it would appear, has Cassini been awarded

the title of ‘The First Astronomer of Europe’!

Painting of Cassini by Leopold Durangel, with the Paris Observatory in the background

Cassini’s lifetime achievements could easily fill an entire book by itself. Starting from humble beginnings, he rose by dint of his sharp intellect, passion and perseverance, to rise to the Directorship of the Paris Observatory, the leading institution for astronomy in the world.

He was the first to provide an accurate estimate of the Astronomical Unit, the distance between the Earth and the Sun. His Tables of the Satellites of Jupiter were the most accurate ones in those times, which enabled an accurate determination of longitude on the Earth, which in turn greatly reduced the errors in the maps of Europe of the day. The western coast of France, for example, was found to be 70 miles less wide than previously thought, which led King

Louis XIV to lament in jest that he was losing more land to his astronomers than to his enemies! In these studies, Cassini also came close to being the first person to determine the speed of light, though the honor would ultimately go to his assistant Ole Romer. Cassini was one of the first scientists to make heavy use of the telescope for astronomical purposes, making numerous ground-breaking discoveries in the heavens. Readers may perhaps know that he was the first to observe a gap in the rings of Saturn, which now goes by his name – the *Cassini Division*. In his honor, about two decades ago, a spacecraft named the Cassini Orbiter was dispatched to Saturn by NASA to study the planet, which recently completed its mission. On the flip side, Cassini is also known for his

entanglements with Isaac Newton on various issues, in all of which Newton ultimately prevailed.

Returning back to our story, coming as it did, from Europe’s top astronomer, Cassini’s detailed description of the data and techniques in the Siamese Manuscript created a great sensation in Europe.

Till that time, it was thought that of all ancient peoples, only the Greeks had cultivated astronomy as a science. Not only were the data and methods of the Siamese Manuscript superior to the Greek, they even rivaled the modern.

Some of Cassini’s interesting observations on the Siamese Manuscript are as follows:

No Tables Used European astronomers of those times used Tables that were painstakingly prepared, to predict the positions of various heavenly bodies like the Sun, Moon and Planets. The *Rudolphine Tables*, compiled by the celebrated Kepler, were the most accurate ones available in Cassini's time. Cassini's first observation was that the Siamese Manuscript used no Tables at all.

These Rules are extraordinary. They make no use of Tables, but only of the addition, subtraction, multiplication and division of certain numbers, of which we do not presently comprehend the basis of, nor to what these numbers refer.

Concealed Data: Cassini determined that the seemingly innocuous numbers

used in the Manuscript were actually based on astronomical data of various types.

Under these numbers are concealed various periods of Solar Years, Lunar Months and other revolutions, and the relationship of the one with the other. Under these numbers are likewise concealed several sorts of Epochs, which are not clearly stated as such, like the Civil Epoch, the Epoch of the Lunar months, that of the Equinoxes, Apogee and the Solar cycle.

Concealed Operations: He found that in several operations in the Manuscript, the calculations were deliberately obfuscated, perhaps to conceal their actual purpose.

Also, the numbers which represent the differences between these Epochs are not clearly specified at the beginning of the operations to which they serve, as they ought to be, according to the natural order. Instead, they are often mixed with certain other numbers, and the sums or differences are multiplied or divided by others, for they are not always simple numbers, but frequently they are fractions, sometimes simple, sometimes compound, without being expressed in the manner of fractions, the numerator being sometimes in one Section and the denominator in another, as if they had a contrived design to conceal the nature and use of these numbers.

Great Accuracy of Data: The length of the Mean Lunar Month given in the

Manuscript was found to be astoundingly accurate. Its value of 29 days, 12 hours, 44 minutes and 2.3 seconds, differed from the most accurate estimate in Cassini's time of 29 days, 12 hours, 44 minutes and 3.1 seconds, by only a fraction of one second! Similarly, the Moon's Mean Apsidal Revolution Period was given as 3232 days, compared to 3233 days in modern times. Also, the 19-Year cycle, called the Metonic Cycle in the west, was known to the Indians with an accuracy within 3 minutes of its modern value, while the western system was off by 1.5 hours. At the end of the 19-Year cycle, the Indian Epact (lag) was automatically zero, while the western calendar lagged by 1 day, which needed a manual correction every 19 years.

The Lunar-Day: The Lunar-Day, which is a little shorter than the Solar-Day, is a unique concept, found only in Indian and Chaldean astronomies. Cassini finds that the Indians base their astronomical calculations almost exclusively on the Lunar-Day, unlike western systems.

Two Zodiacs: Cassini determines that the Indians appear to use two Zodiacs: 1) comprising the regular 12 constellations or signs, and, 2) one comprising 27 constellations. Both the Indian Zodiacs were fixed ones, unlike the Greeks, whose 12-sign-Zodiac was movable.

In summary, Cassini, in his brief memoir, is all praise for the Indian Astronomical system as found in the Siamese Manuscript:

These Rules are ingenious, and once understood clearly and purged of needless superficialities, they should prove useful to us in Europe, since they are easy to apply without the need of books (Tables).

He praises the Indian Calendric system, which, he marvels, had not run into any serious problems since its inception, and continues to be sufficiently accurate even after a thousand years, whereas the Western system had run into difficulties over time.

Thus, it appears that the calendar of the Indians has not run into the error which our old calendar had fallen into, where the New Moons were regulated by the cycle of the Golden Number.

After calculating New Moons for various months in his time (for the 1600s and 1700s), Cassini marvels that the results using the Indian methods match very well with those of the latest methods of his time (Rudolphine Tables).

Having by the same method calculated, according to the Indian Rules, the middle conjunctions of the Moon with the Sun for several years of this and the following centuries, we have always found that every one of these conjunctions fell upon a day whereon the middle conjunction happened according to our Tables.

As an aside, Indian texts on astronomy usually fall into one of three categories – Siddhanta, Tantra or Karana. Unbeknownst to Cassini, the Siamese

Manuscript was only a Karana text, and not a full-fledged Siddhanta.

A Siddhanta is a full treatise, which starts with the fundamentals, and undertakes a complete and rigorous theoretical treatment of all topics on the subject. It does not provide examples, practical shortcuts and other such conveniences. It is written with the mathematician and theoretical astronomer in mind. A Karana text lies at the other end of the spectrum. It is composed for the benefit of the village astrologer; one whose needs are completely practical, and who is not very concerned with the background of his calculations, or with the theoretical aspects of the model. It usually has very simple and concise instructions, cryptic formulae, shortcuts and examples, with

little or no explanation provided. A Tantra text falls in-between these two types.

It is interesting to speculate what Cassini would have remarked, had he come across a full Indian Siddhanta of Astronomy. Interested readers can check out the full story of the Siamese Manuscript in my recent book.

There was always the evangelical side of Christian Europe, in which missionaries and Jesuit scholars travelled to far-off places, studying local religions, customs, and the state of the sciences, and funneling back that information to Europe in a steady trickle, including

information on mathematics and astronomy.

Phase-I (Discovery and Euphoria)

We have read about Europe's discovery of Indian Astronomy in 1691, via the Siamese Manuscript, and the great curiosity and awe that it aroused among European scholars of those times – somewhat like having discovered an advanced alien civilization.

At the end of the 17th century, Europe was still in the incipient stages of its meteoric rise in the modern world, and not yet the colonizing juggernaut that it would soon become. For the sea-faring nations of Europe, their primary interest in the East still lay in getting a foothold and expanding commerce, while at the

same time disrupting the trade of their enemies. With intense rivalry in commerce ongoing between these countries, it is only to be expected that the state of the sciences in the eastern nations they were trading with was the least of their concerns.

And thus, it happened that nearly 80 years passed, before the next major advance occurred in Europe regarding Indian Astronomy, when the French astronomer Guillaume Le Gentil visited Pondicherry in 1768.

But it must be mentioned that these intervening 80 years were not completely devoid of any updates. There was always the evangelical side of Christian Europe, in which missionaries and Jesuit scholars travelled to far-off places, studying local

religions, customs, and the state of the sciences, and funneling back that information to Europe in a steady trickle, including information on mathematics and astronomy. Researchers in the History of Science will often find a treasure trove of information in the records of these Jesuit exchanges.

We examine below a few samples of such missionary and Jesuit activities in India.

Bayer’s ‘History of the Bactrian Greek Kingdom in India’ (1738)

Theophilus Siegfried Bayer was a German scholar of Oriental studies, based at the St. Petersburg University in Russia. Though he never ventured east of Petersburg, he did develop several

contacts in the East, using which he built up an impressive database on Asian History and Culture, amassing a great collection of eastern books, coins and other artifacts. He published his findings and his opinions in a book which focused primarily on the Bactrian (Greek) Kingdom in the North-West corner of India.

Primarily a sinologist, a scholar with an interest in China, he built up an extensive network of communications with Jesuits based in India, China and elsewhere. In India, his contacts were mainly in the southern Tamil province, from whom he regularly received information on Indian astronomy and Calendrics, and also copies of Almanacs that were in use in the southern province at the time.

He often wrote to these Jesuits expressing his gratitude for the information and exchange of views[1]. We find mentioned in these conversations the fact that the Chinese knew of the 19-year Metonic astronomical cycle long before the Greeks discovered it. Bayer also speaks of the similarities between Indian and Greek astronomies, and expresses the view that the Greeks borrowed their astronomy from India. For example, in a letter to missionaries Kogler and Pereira, he wrote: "*the Greeks received much of their astronomical knowledge from India, and it would be wonderful if there was some evidence of China also being a source.*"

From one C. T. Walther, a Danish missionary at Tranquebar

(Tharangambadi in Tamil Nadu), Bayer received some notes on ‘The Indian Doctrine of Time’, which eventually found a place in the appendices of his book. Both Bayer and Walther admitted to not fully understanding some of the Indian computations and the numbers employed in the Tranquebar notes. Bayer eventually reached out to Euler, in the Mathematics Department at St. Petersburg, to try and resolve his difficulties, and thus it was that the greatest mathematician in the world entered the arena of Indian Astronomy.

Euler on Indian Astronomy

It has been debated whether Leonhard Euler was the greatest mathematician of all time – the other contenders being Gauss and Newton. But, greatest or not,

he certainly was the most prolific mathematician ever, producing over 800 papers, articles and books. The French mathematician Pierre-Simon Laplace put his views of Euler succinctly as: “Read Euler, He is the master of us all.” Such was Euler’s reputation as a calculating machine that philosopher De Condorcet described his passing away as: “He

ceased to calculate, and to live “.

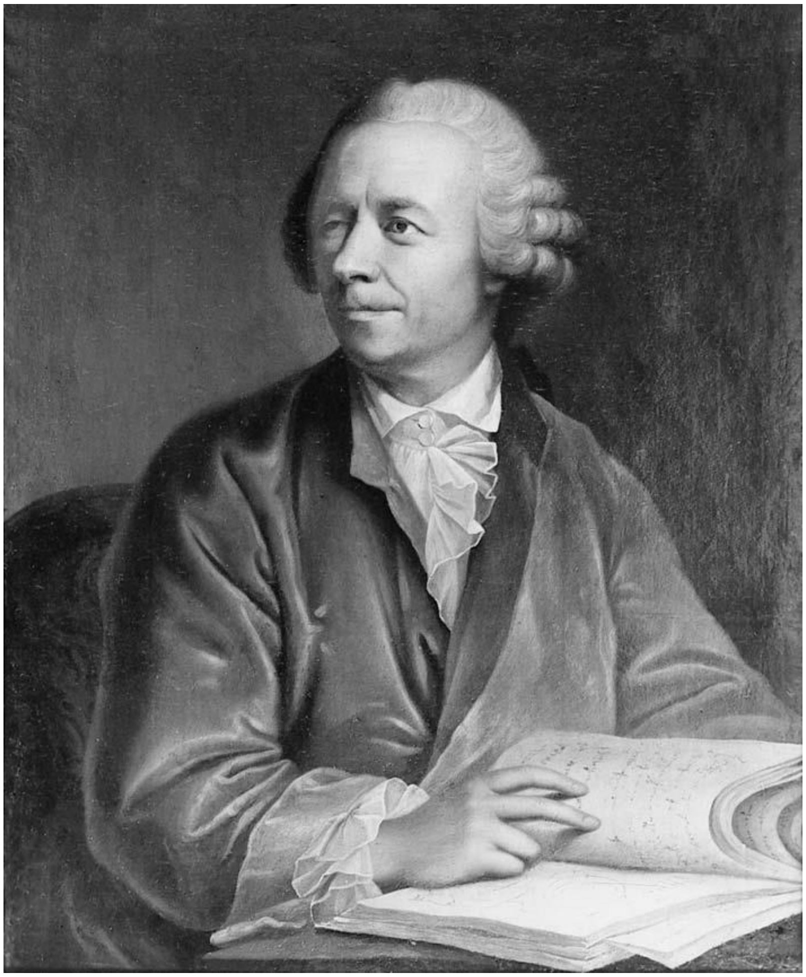


Fig. 1 Leonhard Euler [Source: ega-math]

India can take some pride in the fact that Euler’s interest in astronomy, and the significant output that followed, was first stoked by Indian Astronomy, when

Bayer asked for his help with the Tranquebar notes.

Euler's response to Bayer's call for assistance appeared in the appendices of Bayer's book as "On the Solar Year of the Indians". In twenty-one points, he brilliantly unraveled the intricacies of the Indian computation. Some of the points he highlighted are as follows[2].

. The Solar Year of the Indians is Sidereal, not Tropical.

This was a surprise to European scholars. It highlighted a significant difference between Indian and Greek astronomies. A Sidereal Year, also called Stellar Year, is the time taken by the Sun to go around the ecliptic and return to the same star. A Tropical Year, used in Greek and

European astronomies, is the time taken by the Sun to go around the ecliptic and return to the Equinox point. The Sidereal Year is 20+ minutes longer than the Tropical, because the Equinox shifts by a tiny amount each year. Due to this difference, the Indian Year will fall back one day every 61 years with respect to the European Year.

- The Sidereal Year of the Indians is of 365 days, 6 hours and 12.5 minutes duration, which is about 2 minutes longer than the best European estimate at the time, of 365 days, 6 hours and 10 minutes.

Euler puts the 2-minute discrepancy down to observational error by the Indians. However, the length of the Sidereal Year is not a constant, but varies

by small amounts over time, mainly due to the influence of the others planets on the Earth’s orbit. Its value has been decreasing, and therefore the Indian length of the Sidereal Year, assuming it was measured accurately, is apparently a more ancient value.

- The Indian Year can start at any time of the day or night.

Euler finds that unlike the European Year, which always begins at midnight, the Indian Year starts when the Sun arrives at a particular point on the ecliptic, which can occur at any hour of the day.

- Euler determines that the Indian Months are varied in length – summer

months are longer than those of winter.

The Sun moves at varying speeds throughout the year – fastest in December and slowest in July. The length of the Indian Month, being in sync with the Sun's motion, implies that the Indians knew of the variation in the Sun's motion. Euler remarks that it would be interesting to know the Indian 'Equation of the Sun', which is a parameter that describes this variation. He has no doubt, he says, that the Indian value of the Equation will be close to the modern European value. In this, however, Euler is mistaken. The Indian Equation for the Sun is quite different from the modern value. It matches, in fact, the correct value from around 5000

BC[3], showcasing the antiquity of Indian astronomy.

- The Indians use two Zodiacs, the first comprising 12 Signs, also used by western astronomy, and the second comprising 27 Signs, which is unique to Indian astronomy. Euler determines that the 27-Sign Zodiac defines a new kind of month used by the Indians – the Sidereal Month.

The Narsapur and Krishnapuram Tables

After Euler's contribution, more than a decade passed before the next couple updates occurred in Europe's knowledge of Indian astronomy, once again, due to the Jesuits.

In 1750, astronomer Joseph Lisle at the French Academy of Sciences received two sets of manuscripts relating to Indian astronomy.

The first was an almanac, entitled ‘Panchanga Siromani’, which was sent from India by a Father Patouillet. This was referred to as the ‘Narsapur Tables’, and was apparently from a place called Narasimhapuram.

The second set was from another Jesuit, Father Xavier Du Champ, who originally sent them to one Father Antoine Gaubil, a French Jesuit working in China. Gaubil forwarded that to Lisle at the Royal Academy of Sciences at Paris. Du Champ was said to have procured these Tables from the Brahmins of Krishnapuram.

Both these sets of Tables, from Narsapur and Krishnapuram, did not attract much attention in Europe initially. These Tables were analyzed in detail several decades later by French astronomer Jean Sylvain Bailly, which we will examine in a later article.

Tycho Brahe and Nilakantha

When Isaac Newton, in all humility, said that he was able to see farther because he stood on the shoulders of giants, he probably had Galileo and Kepler in mind. Kepler, in his turn, can doubtless give some of the credit for his 'giant-ness' to Tycho Brahe.

Tycho (1546-1601) was a Danish astronomer whose efforts laid the foundation for a huge leap in Europe's

astronomical knowledge. He was the most skillful and passionate (some would say fanatic) astronomical observer of the pre-telescope era. Feeling unsatisfied with the ancient Greek planetary models, he created some models of his own. But, understanding that his new planetary theories were toothless without good observational data to back them up, he made up his mind to create a vast repository of the most accurate observational data ever, and succeeded.

Tycho then hired Kepler, mainly for his mathematical skills, and asked him to use the new observational data-bank to prove the validity of his latest planetary model – the *Tychonic Cosmological Model*, in which the Sun and Moon orbited around the Earth while the other planets moved

around the Sun. Kepler struggled for many years to fit the observational data into Tycho’s model, and failed. Tycho’s model was actually off by only a few minutes of arc, which may have been acceptable to a lesser man, but not to Kepler. He had the mathematician’s penchant for absolute accuracy. It is well-known that in the end Kepler dropped Tycho’s model, and tried a simple ellipse instead, which fit the observational data perfectly. At long last, mankind’s quest to understand the clockwork that moves the heavens had been fulfilled.

Returning back to our story on Jesuit activity in India, the *Tychonic Cosmological Model*, now an uninteresting historical relic, suddenly

becomes fascinating and thought-provoking, when we note that it is EXACTLY the same model as proposed a century earlier by Nilakantha Somayaji, an Indian astronomer of the Kerala School.

Was there a Jesuit connection here? Did Tycho somehow get access to Nilakantha's work? Christian missionaries were certainly very active in the southern coastal states of Kerala and Tamil Nadu. But so far, no documentary evidence has been unearthed to support that hypothesis. But before you make up your mind, please read on to the next section.

Copernicus, Nilakantha, Al-Tusi and Al-Shatir

Everyone knows that it was Nicolaus Copernicus who first proposed a heliocentric model for the Solar system. But not many know that only a few years earlier, the Indian astronomer Nilakantha Somayaji had proposed a very similar system, known as the semi-heliocentric model.

Was Copernicus influenced by Nilakantha? The dates of the two, Nilakantha (1444-1544) and Copernicus (1473-1543), are certainly close enough to stir the imagination. Nilakantha completed his astronomical work (*The Tantrasangraha*) in the year 1500, while Copernicus is known to have first

mentioned the heliocentric idea in a letter to a friend in 1514, though it took him another 30 years to publish his revolutionary book.

A stronger evidence of Copernicus benefitting from foreign transmission is found in the close resemblance of his planetary models with those of Islamic astronomers Al-Tusi and Al-Shatir.

Ibn Al-Tusi (1201-1274) was a Persian astronomer who studied the Greek planetary models and found them wanting. He improved the Greek models by created a geometrical technique called the Tusi-Couple to replace some problematic features in the Greek system. The Tusi-Couple somehow found its way into Copernicus's heliocentric model.

Ibn Al-Shatir (1304–1375) was a Syrian astronomer who worked as timekeeper at the Umayyad Mosque in Damascus. After detailed observation of several eclipses, he concluded that the angular diameters of the Sun and the Moon did not agree with Greek predictions. He soon set about making major reforms to the Greek system using the Tusi-Couple. Two centuries later, Al-Shatir's models were found duplicated, almost EXACTLY, in the works of Copernicus. For example, the Table below shows the Lunar Model parameters in the Al-Shatir and Copernicus models of the Moon[4]:

Item	Al-Shatir	Copernicus
First epicycle radius to	0.109722	0.1097

deferent ratio		
First epicycle motion (°/day)	13.06493657	13.06498372
Second epicycle radius to deferent ratio	0.023611	0.0237
Second epicycle motion (°/day)	24.38149538	24.381612
Mean Sun motion	0.9856012180	0.98558966

(°/day)		
Mean Moon motion (°/day)	13.17639452	13.17639452

Did Copernicus have access to Al-Shatir's work? It does appear highly likely. In fact, it becomes conclusive, when we note that a mistake Al-Shatir made in his model for Mercury was also found duplicated in Copernicus's model for that planet.

The Kerala School of Mathematics and Astronomy

On a hot Saturday afternoon, sometime in the early 90s, I walked into the Theosophical Society Building in Adyar,

Chennai, out of curiosity. I had often passed the Society Campus, which is a 10-minute bicycle ride from IIT Chennai, where I was a research scholar. As I wandered into the Library room, I saw an elderly man seated at a table studying and copying some crumbling and decrepit-looking manuscripts. He saw me and cordially asked me to sit beside him on the long bench and enquired why I had come. We spoke for a few minutes after which I left. There are two things I recall about that meeting. Firstly, he said he was retired, and was volunteering his spare time in copying out ancient manuscripts for the archeological department. Secondly, it struck me odd that though he spoke English with a distinctive South-Indian-Malayali accent,

he pronounced his name with a North-Indian inflection as ‘Sharma’.

Looking back, many years later, I realized that the chance meeting had brought me face-to-face with K. V. Sarma, the greatest authority on the Kerala School of Mathematics and Astronomy, and author of over 200 books and research papers.

It had long been held that Indian astronomy had gone into limbo after Bhaskara-II (AD 1114). Professor Sarma has been responsible, almost singlehandedly, for turning that view on its head. His diligent research, over several decades, unearthed not just a few, but several hundreds of ancient documents and manuscripts, highlighting the works of dozens of astronomers and

mathematicians of medieval Kerala. There is probably enough material there for scholars to explore for the next 100 years.

The Kerala School was discovered by an Englishman in the early part of the 19th century. Charles Matthew Whish, having completed his law course in England, arrived in India in 1812 to take up a legal position at a district court in South Malabar in Kerala. An expert linguist, he soon mastered the local dialect, and even published a book on grammar of the native language. He was favorably disposed to the natives and struck up friendships with a few, including a famed mathematician – a younger prince of the Royal family.

During his research on how calendars were being constructed by the natives, he made some curious discoveries. The Indians appeared to have discovered, among other things, the series expansion method to determine approximations to PI (ratio of circumference to diameter of a circle), several centuries before the Europeans had made that finding.

When he discussed this with some senior colleagues of the East India Company, they dismissed it as impossible: *The Hindus never invented the series; it was communicated with many others, by Europeans, to some learned natives in modern times. The pretensions of the Hindus to such knowledge of geometry is too ridiculous to deserve attention.*

Whish initially accepted their opinion, but continued his studies on Indian mathematics. In course of time he came upon further material to support his thesis, at which point he felt bold enough to publish his findings in a paper: *On the Hindu Quadrature of the Circle*.

He wrote: *The approximations to the true value of the circumference with a given diameter, exhibited in these three works, are so wonderfully correct, that European mathematicians, who seek for such proportion in the doctrine of fluxions, or in the more tedious continual bisection of an arc, will wonder by what means the Hindu has been able to extend the proportion to so great a length.*

And further: *Some quotations which I shall make from these three books, will*

show that a system of fluxions peculiar to their authors alone among Hindus, has been followed by them in establishing their quadratures of the circle; and a few more verses, which I shall hereafter treat of and explain, will prove, that by the same mode also, the sines, cosines, etc. are found with the greatest accuracy.

Whish had stated that he would soon be presenting more results in a separate paper. That, unfortunately, never came to pass, as he shortly afterwards lost his job at the Company. He was reinstated after a year, but died soon thereafter in 1833 at the young age of 38. Expectedly, given the colonial mindset of the British, nothing further was heard on the subject of the development of infinite series in India till the middle of the 20th century,

when some Indian scholars came upon Whish's papers.

Since then, thanks to the efforts of Prof. Sarma and others, the contributions of the Kerala School have made inroads into the famous names of mathematics. The Leibniz-Series is now called Madhava-Leibniz-Series after the founder of the Kerala school. Similarly, the Gregory-Series for the power series expansion of the arctangent function is now called Madhava-Gregory-Series, etc. Scholars are now actively pursuing the possibility of Calculus having been developed in India 300 years before its re-discovery in Europe. Others are looking into the likelihood of Jesuits enabling the transmission of the fundamental ideas of Calculus from India

to Europe. Exciting times ahead for Indian Mathematics!

On the Astronomy side, apart from the similarities of Tycho's and Copernicus's models to Nilakantha's, there is little else to go by, for now. Prof. Sarma's treasure-trove of astronomical documents relating to the Kerala School, more than 400 of them, awaits researchers.

Closure

In this article, we touched upon how Christian missionaries and Jesuits, travelling to far-away lands, may have contributed to the development and growth of mathematics and astronomy in Europe.

In the next article, we will read about the epic saga of Monsieur Guillaume Le

Gentil, and his 11-year wandering around the Indian Ocean, all for the sake of Astronomy, and how his arrival in Pondicherry led to the second major update in Europe on Indian Astronomy.

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